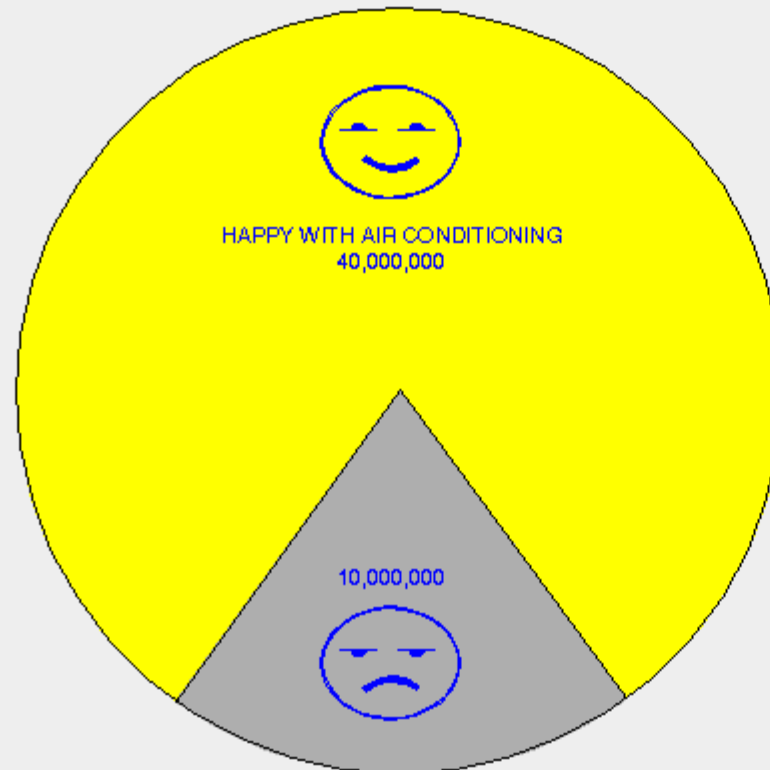


# **CASE STUDY**

## **INDIVIDUAL TEMPERATURE CONTROL**

TAMBLYN CONSULTING SERVICES  
AUGUST 2003  
TEL: 416-226-6565

## OFFICE WORKERS IN AMERICA



### SALARY OF UNHAPPY WORKERS

$$\frac{10,000,000 \times \$35,000/\text{YR}}{250 \text{ DAYS/YR}} = \$1,400,000,000/\text{DAY}$$

### AVERAGE SICK DAYS BLAMED ON AIR CONDITIONING

2 / YR

### COST OF UNHAPPY WORKERS

$$2 \times \$1,400,000,000 = \$2,800,000,000/\text{YR}$$

### QUESTION:

FOR **\$2,800,000,000/YR** IS IT WORTH TRYING HARDER  
TO DESIGN A BETTER AIR CONDITIONING SYSTEM  
**????**

BUILDING QUALITY REVIEW  
FOR PUBLIC WORKS CANADA  
BY DECIMA RESEARCH

IMPORTANT ISSUES  
(IN ORDER)

1. HVAC
2. LIFE SAFETY
3. CLEANING
4. ELEVATORS
5. SECURITY

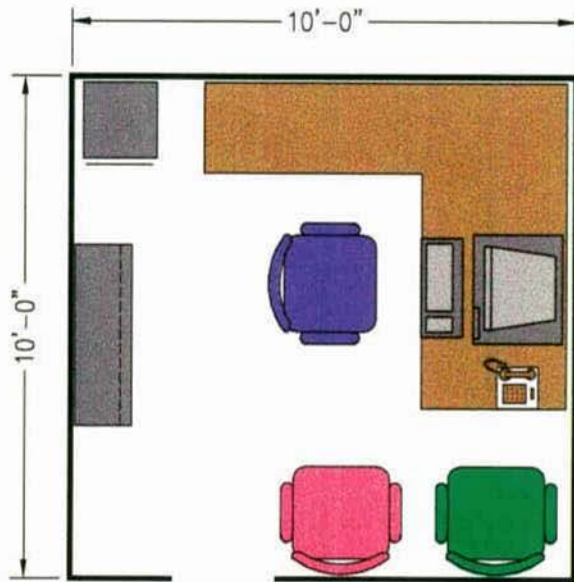
LOWEST  
SATISFACTION LEVELS

1. HVAC
2. TENANT NEWSLETTER
3. PARKING SECURITY
4. LUNCH ROOM SERVICE
5. LOBBY APPEARANCE
6. EMERGENCY PROCEDURE  
TRAINING

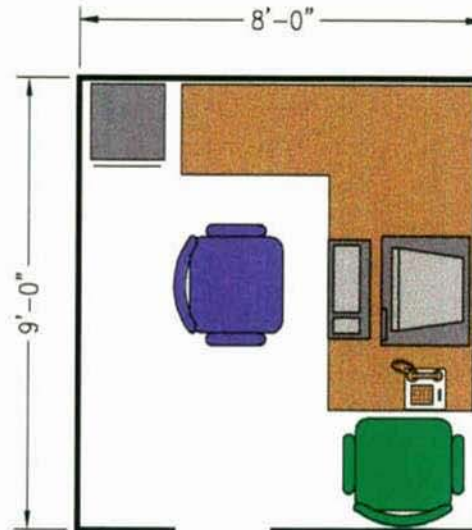
CAUSES OF DISSATISFACTION

1. LACK OF INDEPENDENT TEMPERATURE CONTROL
2. LACK OF AIR MOVEMENT CONTROL
3. LACK OF GOOD VENTILATION
4. CROWDING OF OFFICE SPACE

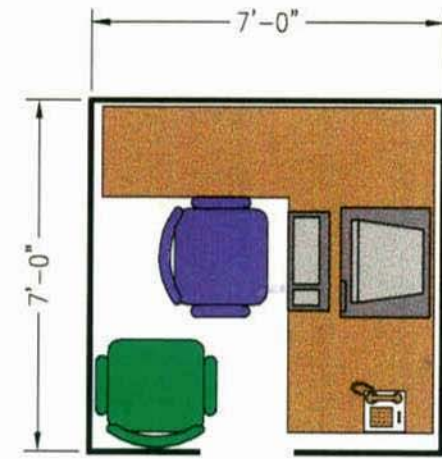
## FORTHCOMING REDUCTION IN WORKSTATION SIZE



SPACE RENTAL  
\$2,000/YR

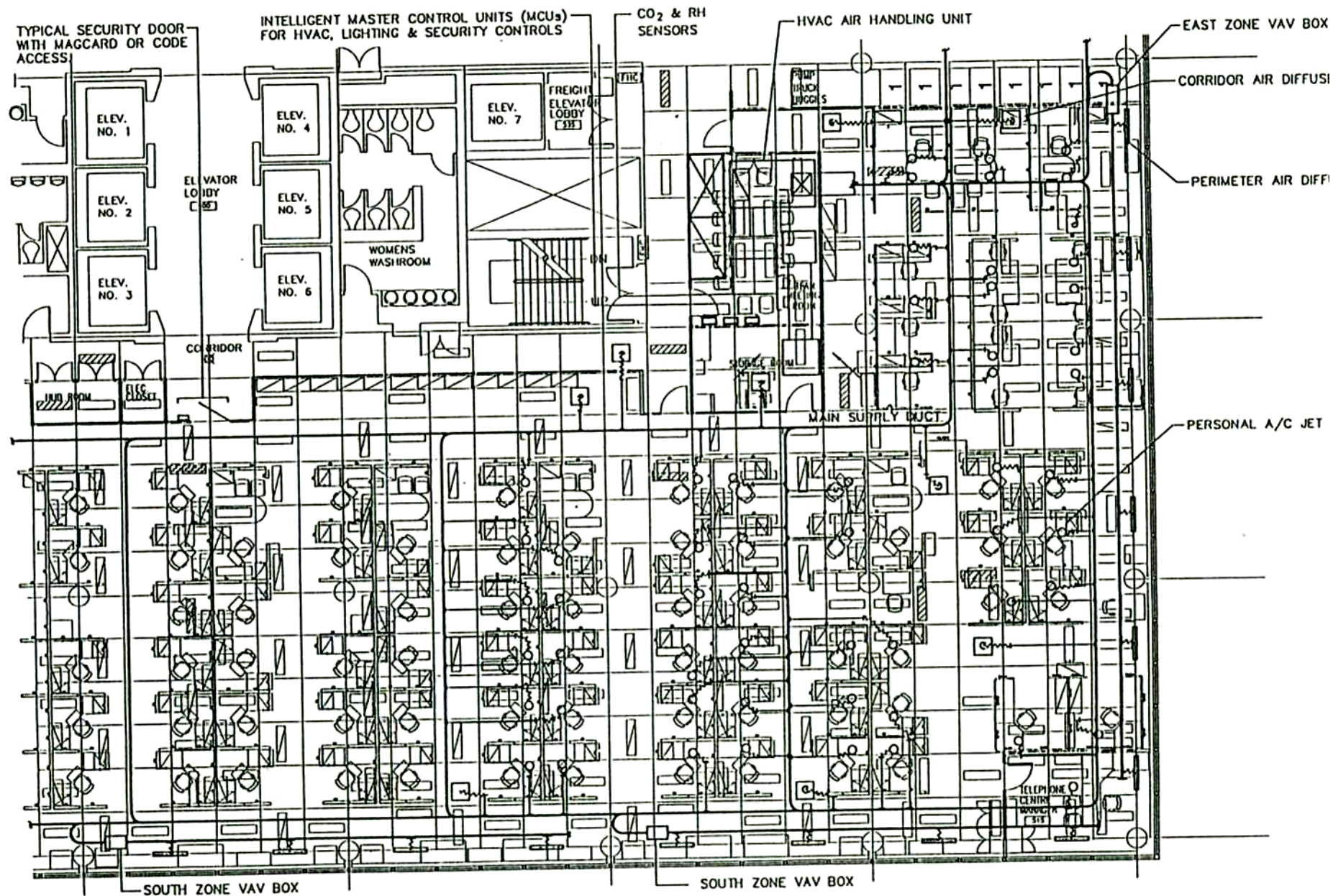


SPACE RENTAL  
\$1,440/YR



SPACE RENTAL  
\$980/YR

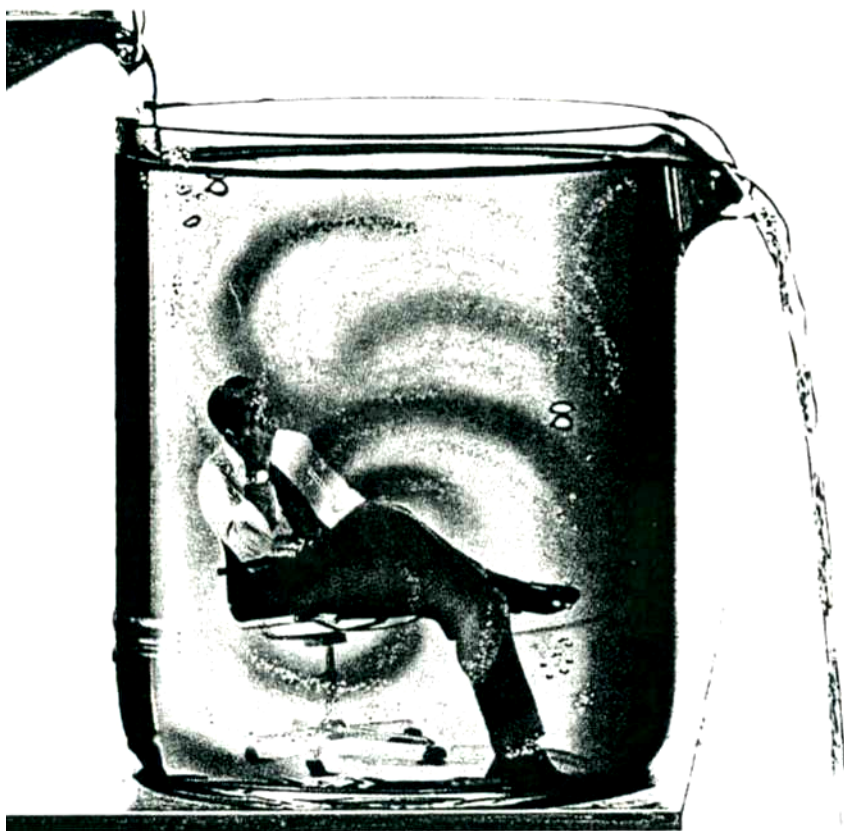
\* SPACE RENTAL ASSUMED AT \$20/FT<sup>2</sup>/YR



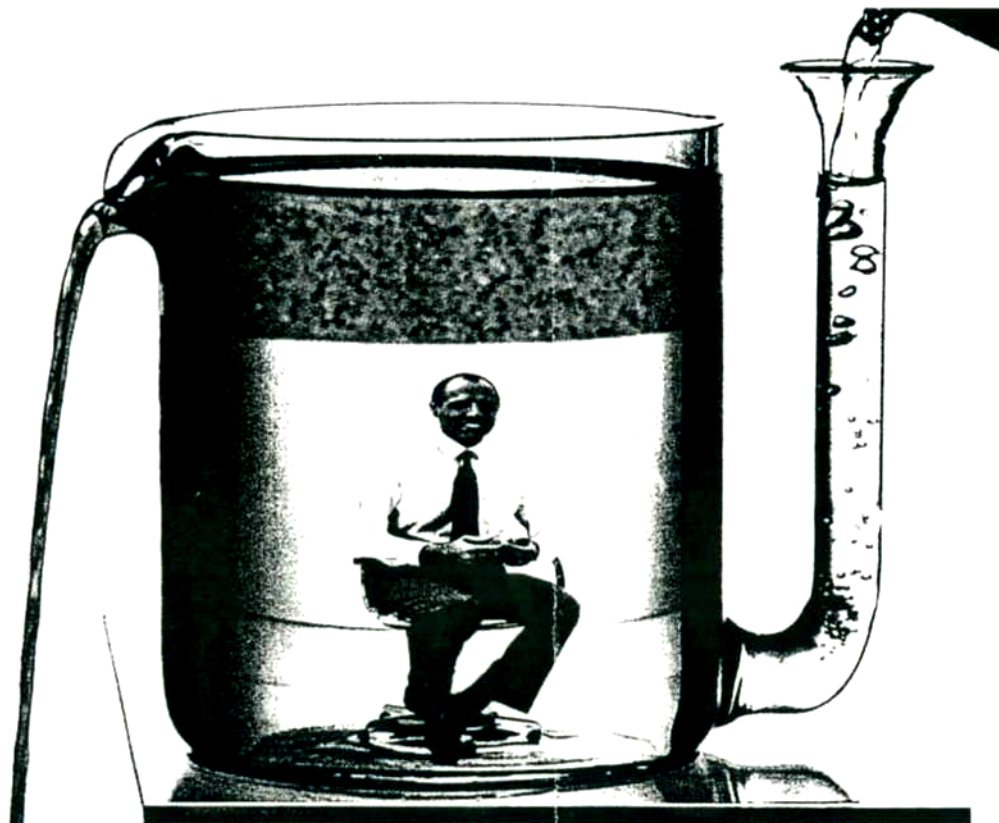
PROPOSED BUILDING CONTROL SYSTEMS FOR INTELLIGENT BUILDING WITH HIGH DENSITY WORKSTATIONS

THE CASE  
FOR  
ZERO COMPLAINT  
IN  
AIR CONDITIONING SYSTEMS

MIXING SYSTEM

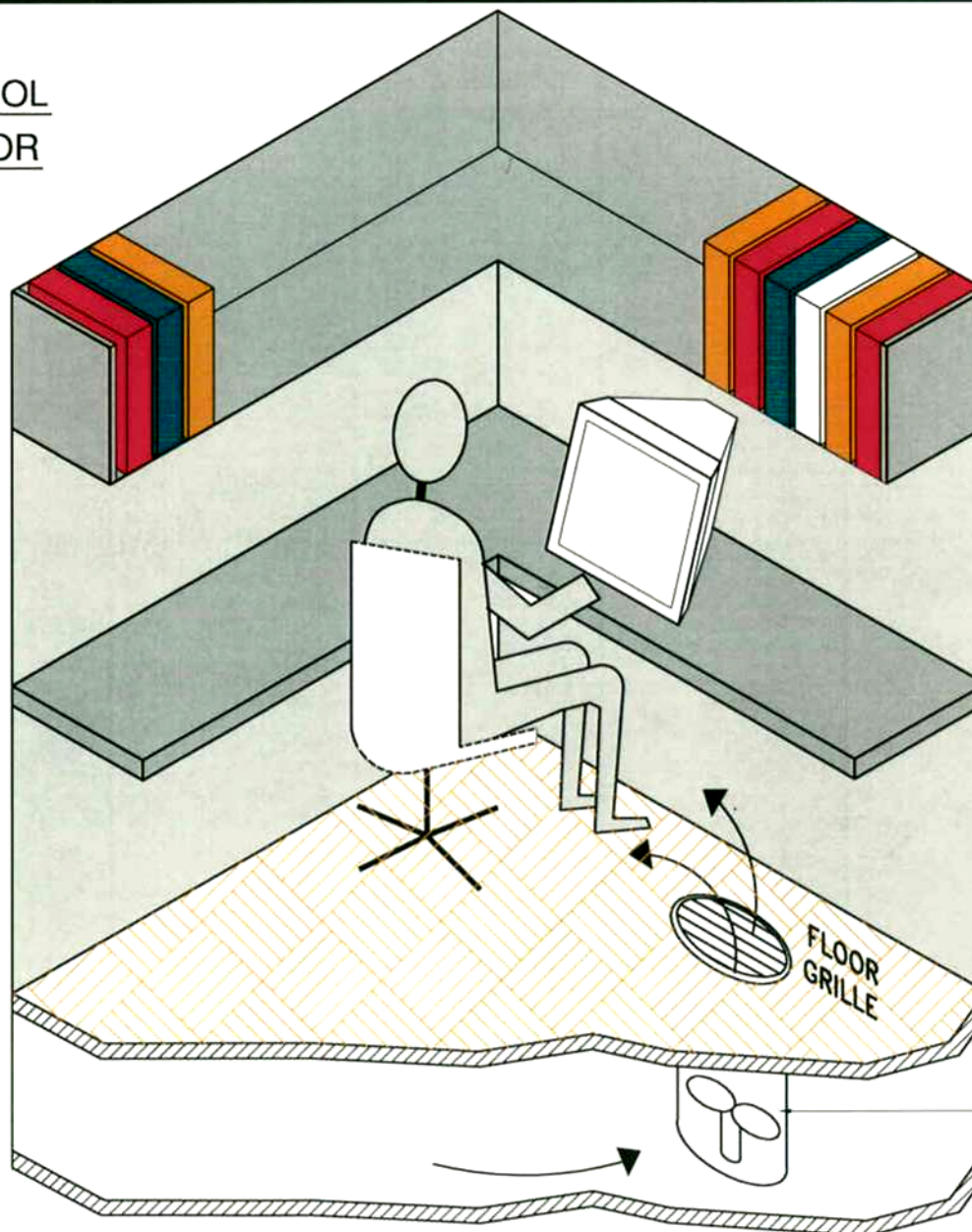


DISPLACEMENT SYSTEM



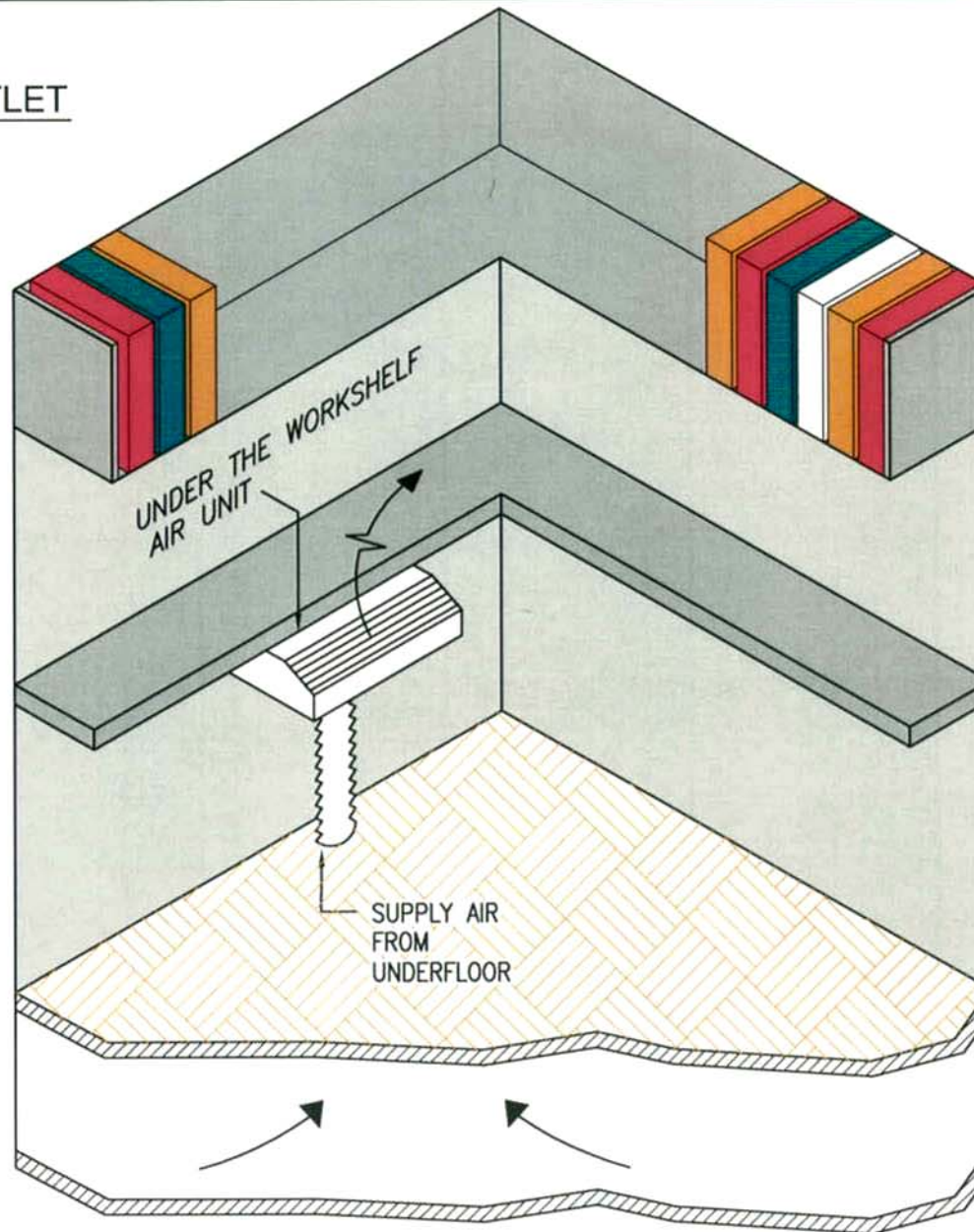
SCANDINAVIAN CONCEPT

INDIVIDUAL CONTROL  
WITH RAISED FLOOR

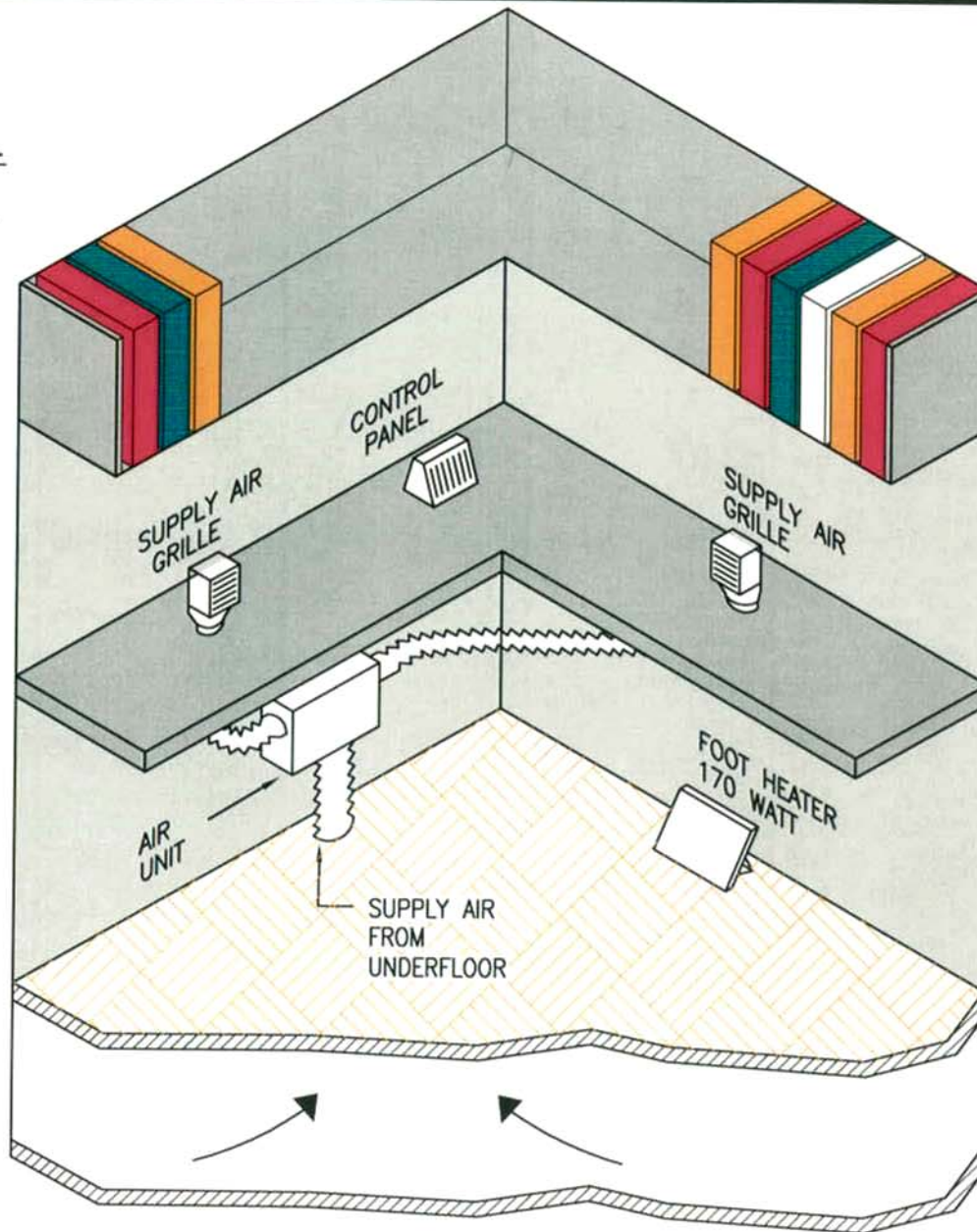


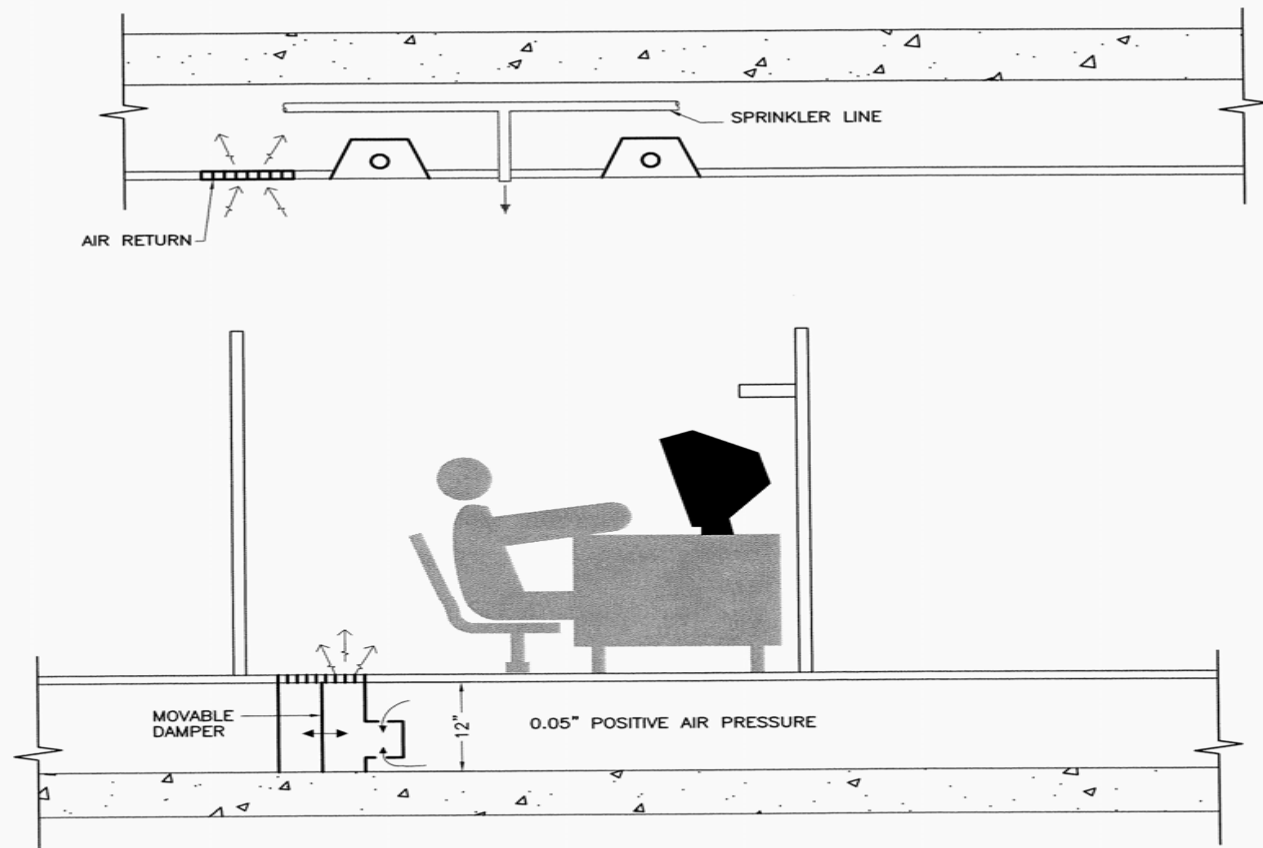
VARIABLE SPEED FAN UNIT  
DRAWS AIR FROM  
UNDER FLOOR SPACE

VARIATION ON  
RAISED FLOOR OUTLET



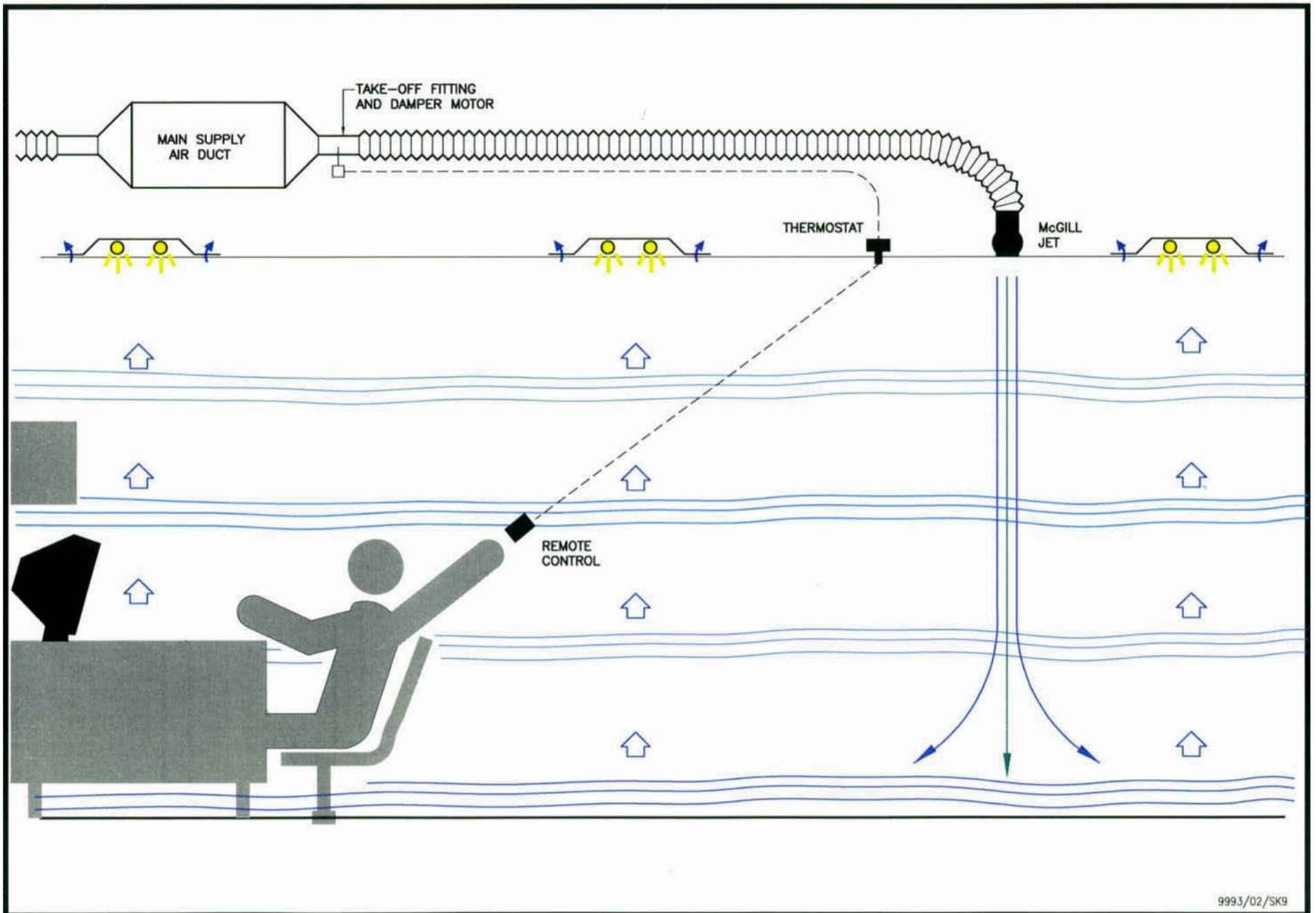
DE LUX  
INDIVIDUAL CONTROL  
WITH RAISED FLOOR

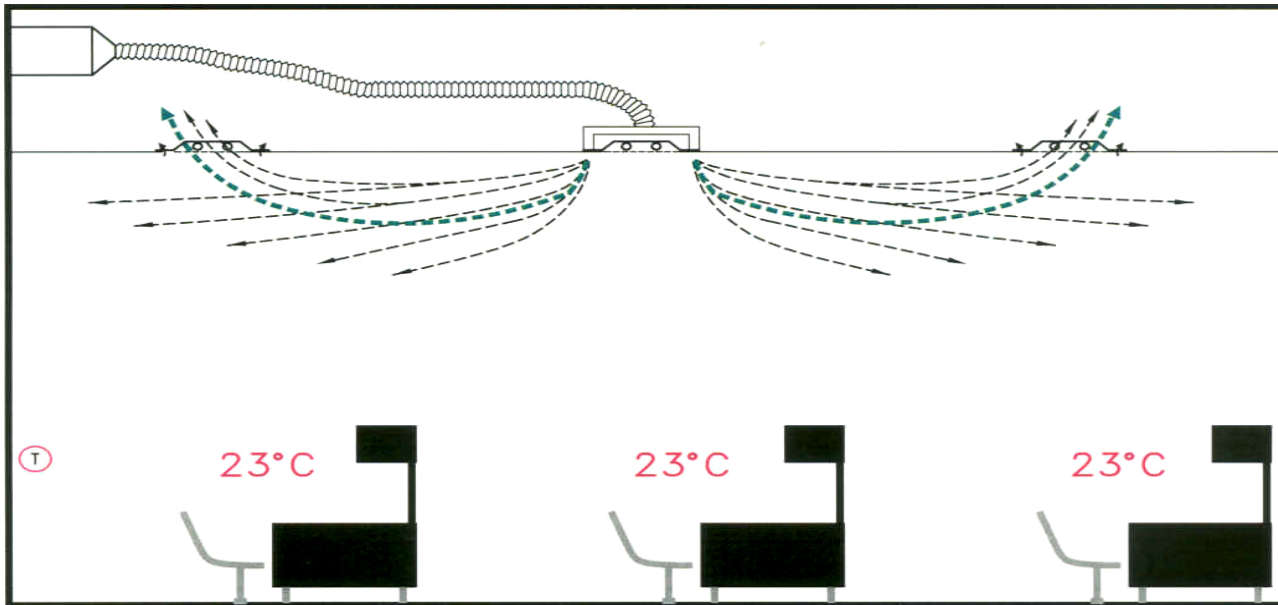




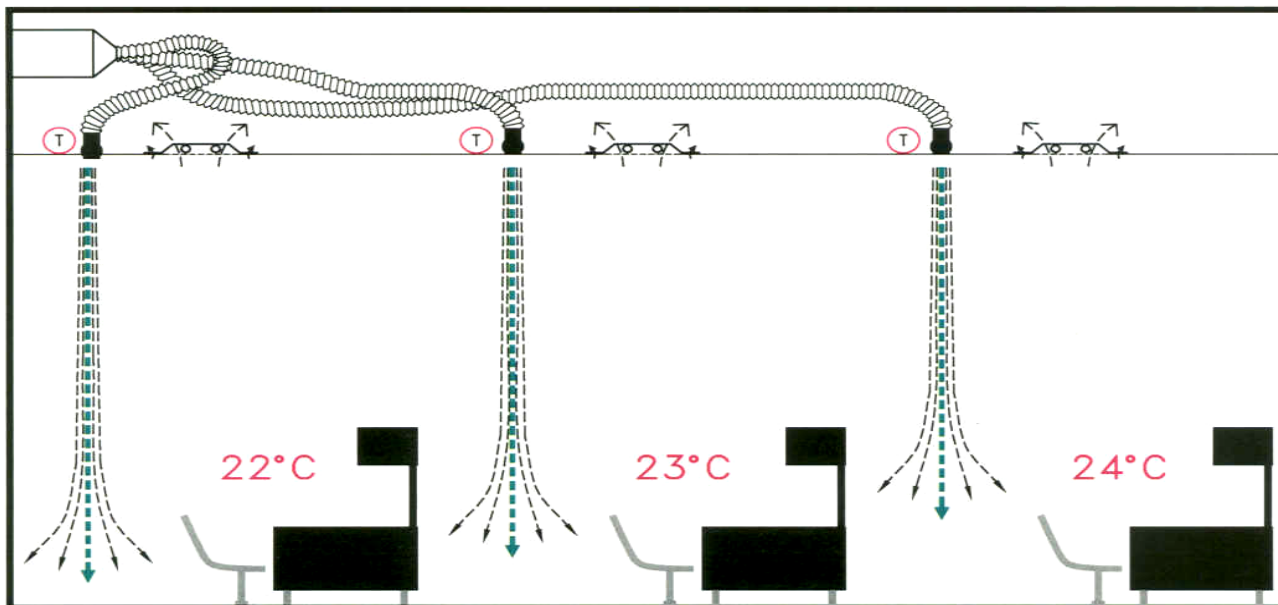
AIR PLENUM SUPPLY AIR

## ZERO COMPLAINT CONCEPT



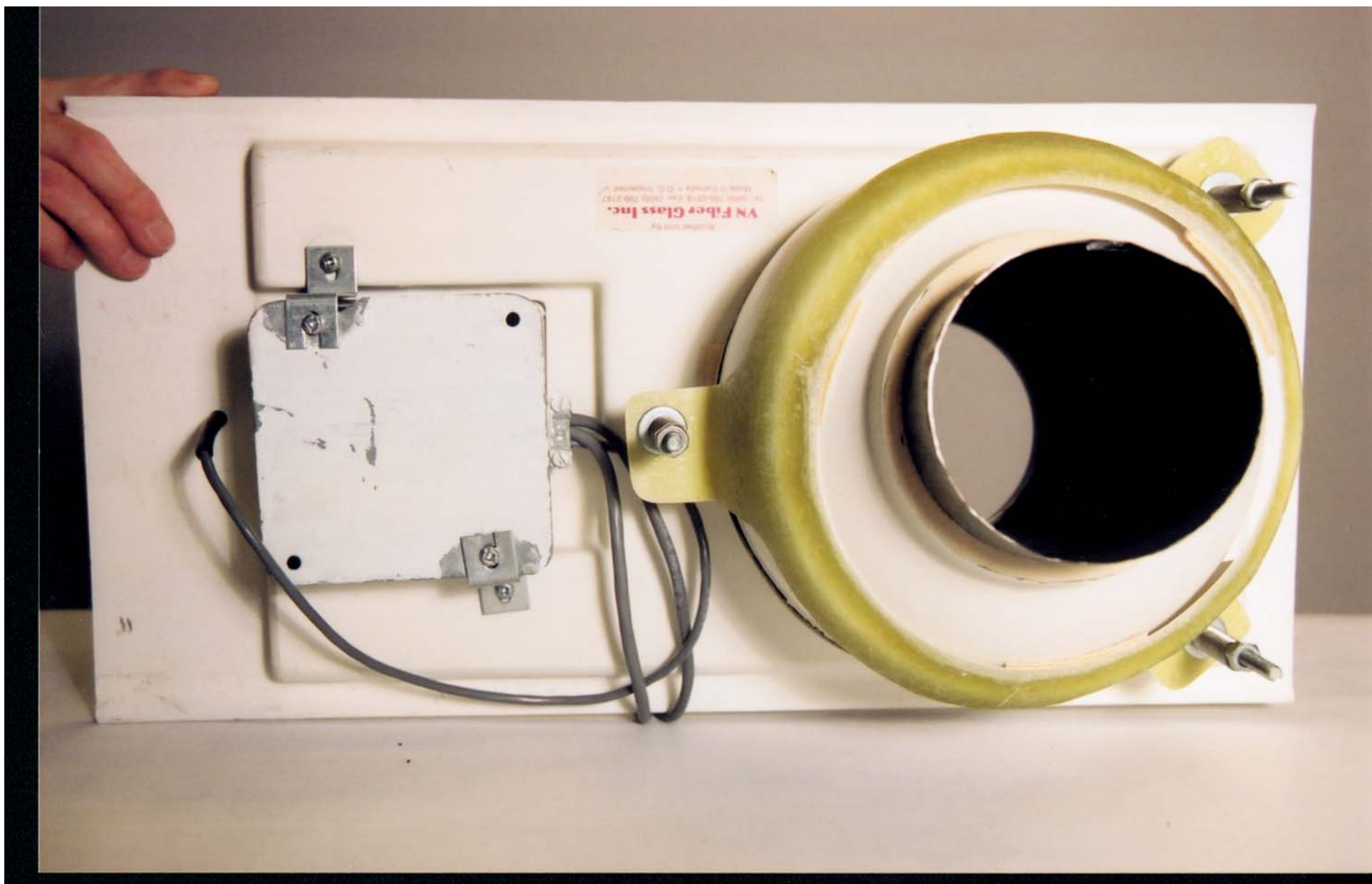


CONVENTIONAL AIR DISTRIBUTION



ZERO COMPLAINT AIR DISTRIBUTION



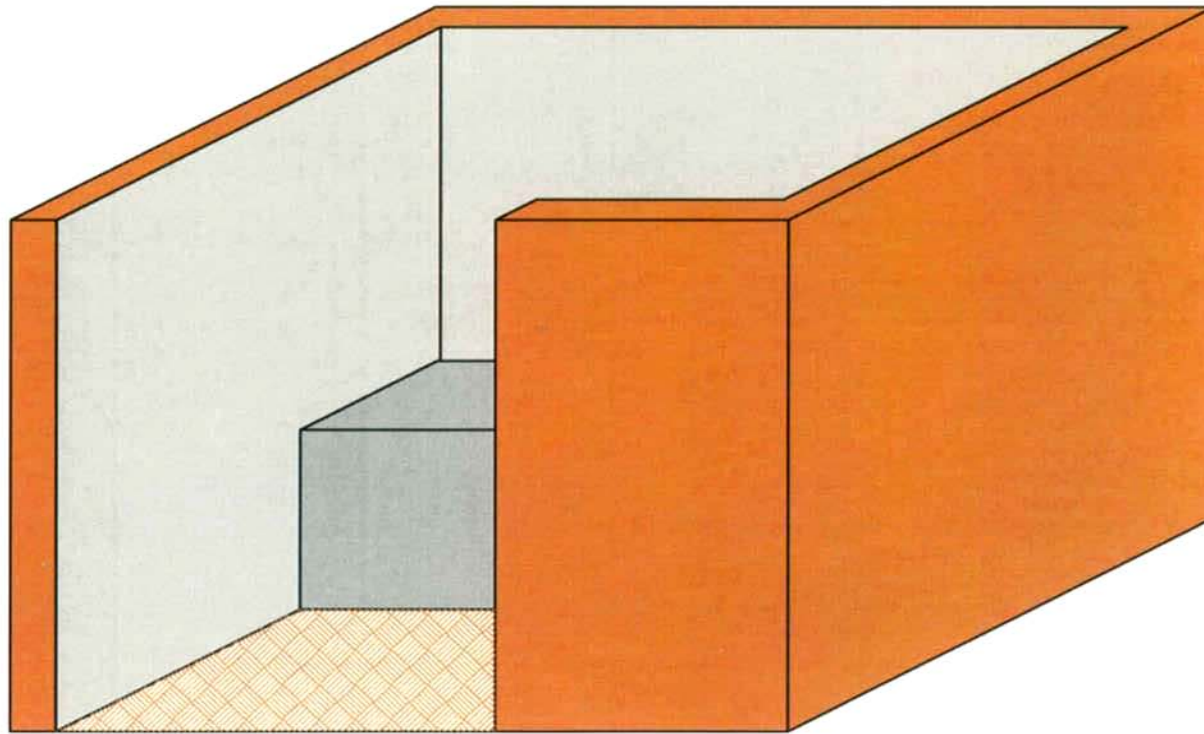
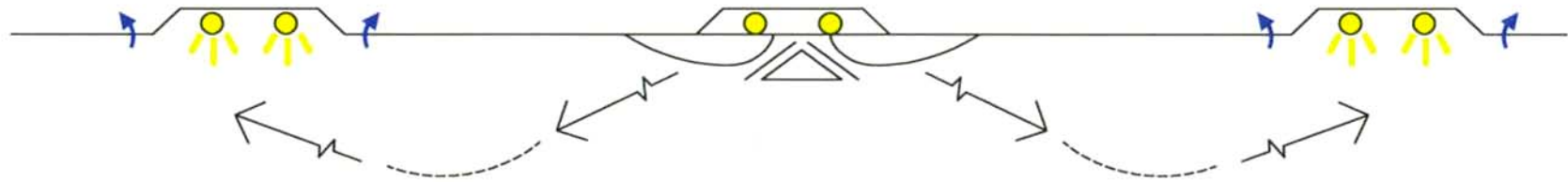






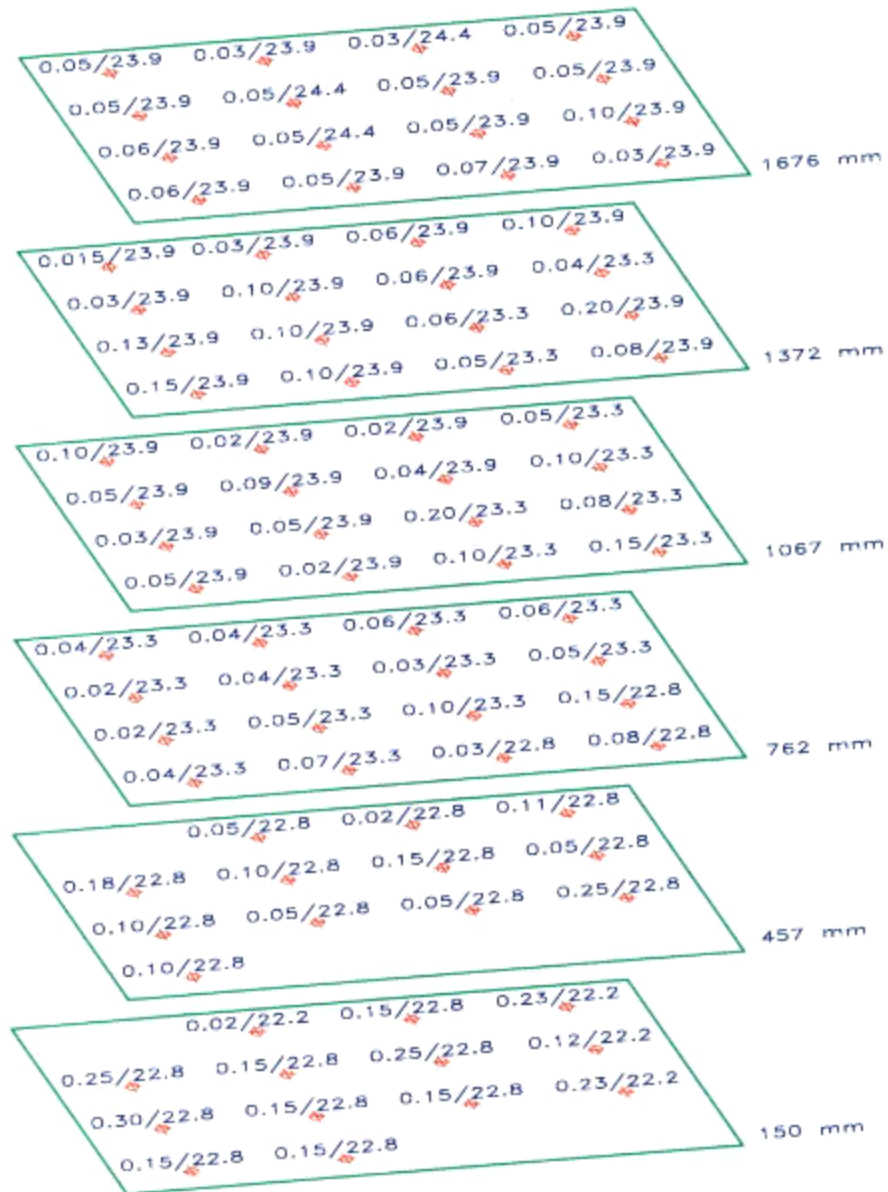


## OVERHEAD VAV



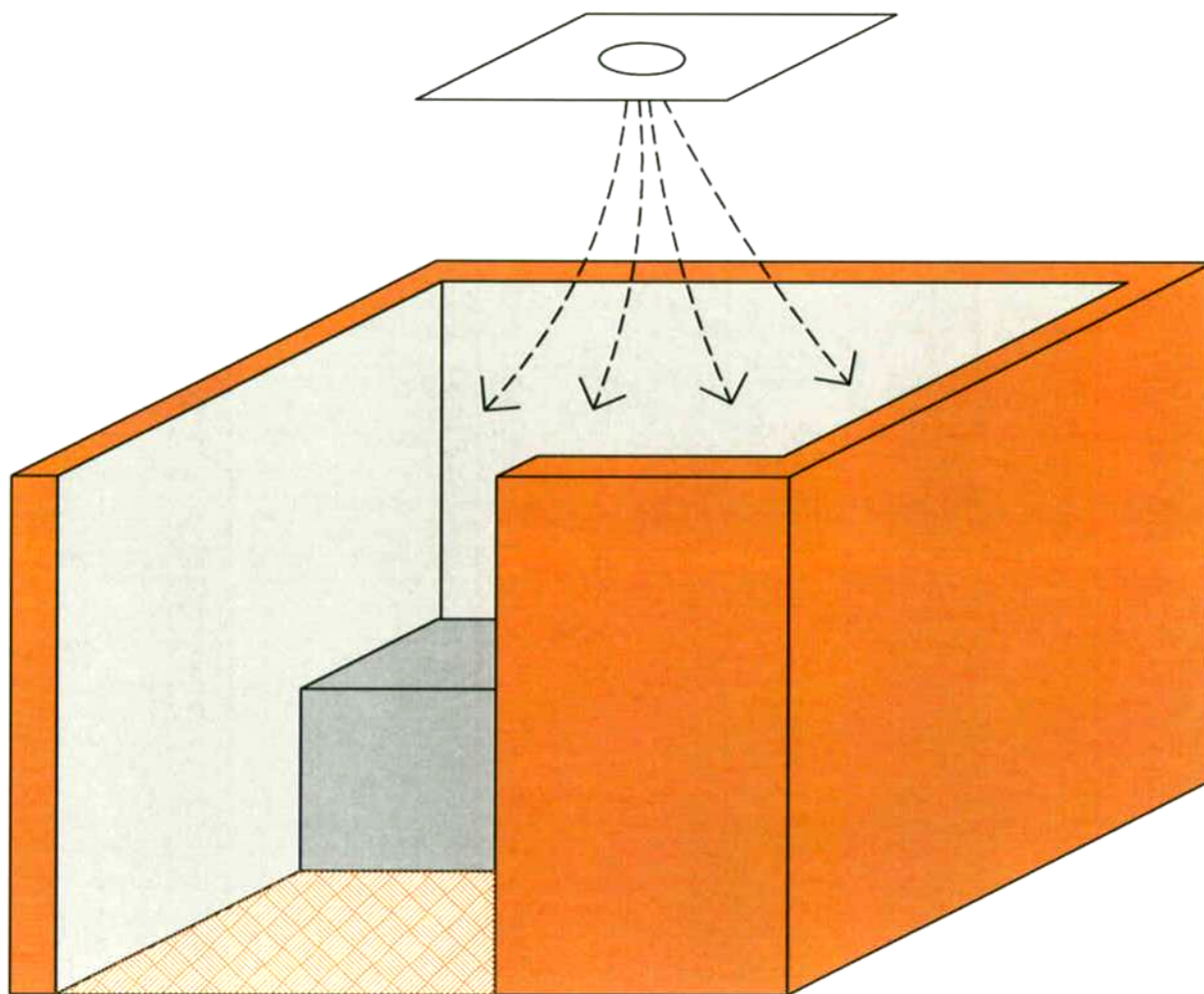
AIR VELOCITY IN WORKSTATION:	0 m/sec
AIR TEMPERATURE IN WORKSTATION UNIFORMLY:	22.8°C

FIGURE 4  
GRID MEASUREMENTS FOR IAN POWER'S OFFICE



LEGEND  
v-t-t-t = Upward velocity (m/s) / Temperature (°C)  
t-t-t mm = height above floor

## ZERO COMPLAINT



AIR VELOCITY	0.15 m/sec AVERAGE
AIR TEMPERATURE	22°C AT FLOOR
	24°C AT TOP OF PARTITION

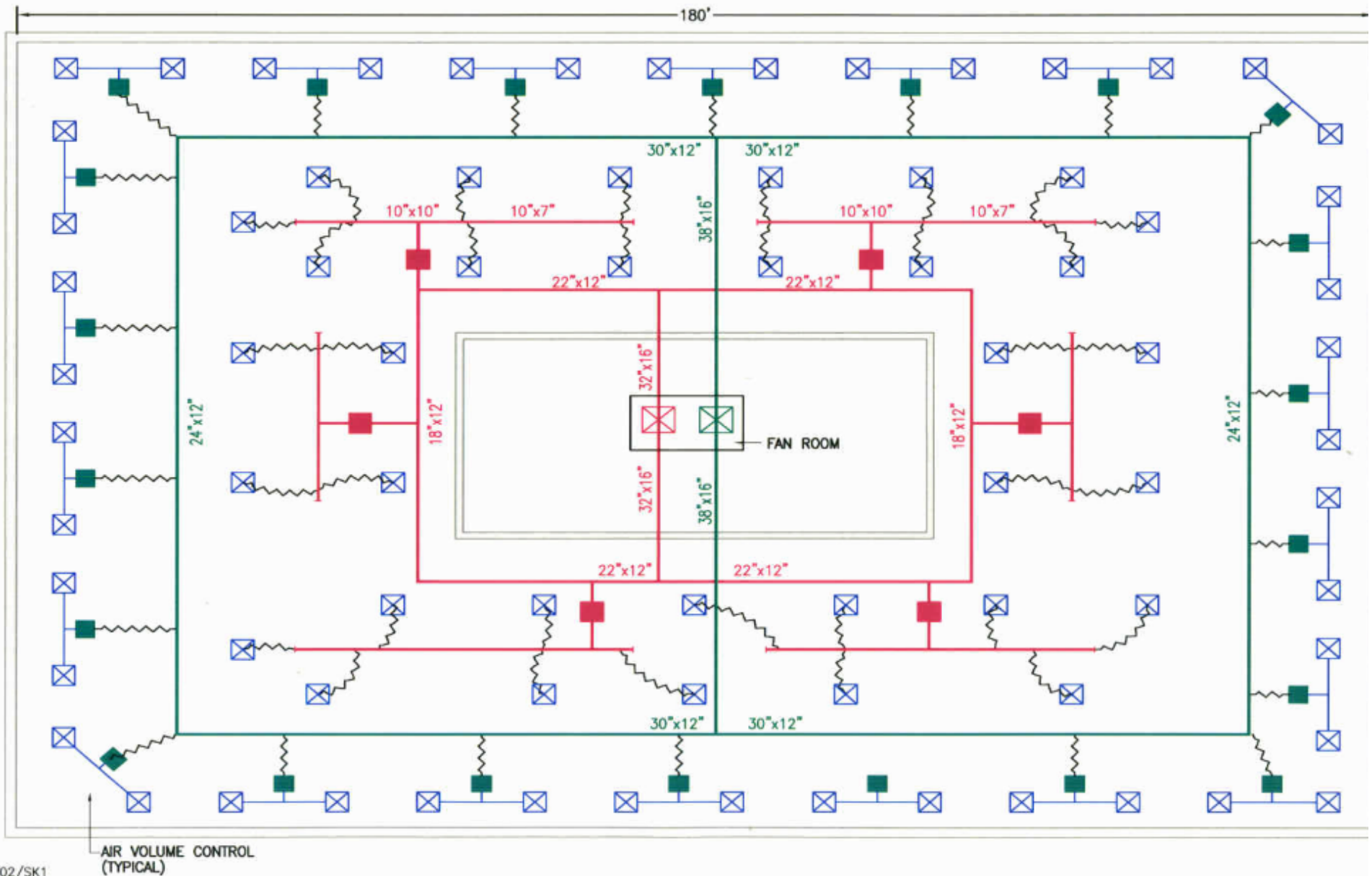
# AIR TERMINALS

22 PERIMETER	AVERAGE 520 CFM
6 INTERIOR	AVERAGE 1450 CFM
TOTAL	19,700 CFM

## TYPICAL HVAC LAYOUT FOR VAV CONTROL

# AIR OUTLETS

44 PERIMETER	AVERAGE 250 CFM
35 INTERIOR	AVERAGE 250 CFM
TOTAL	19,700 CFM



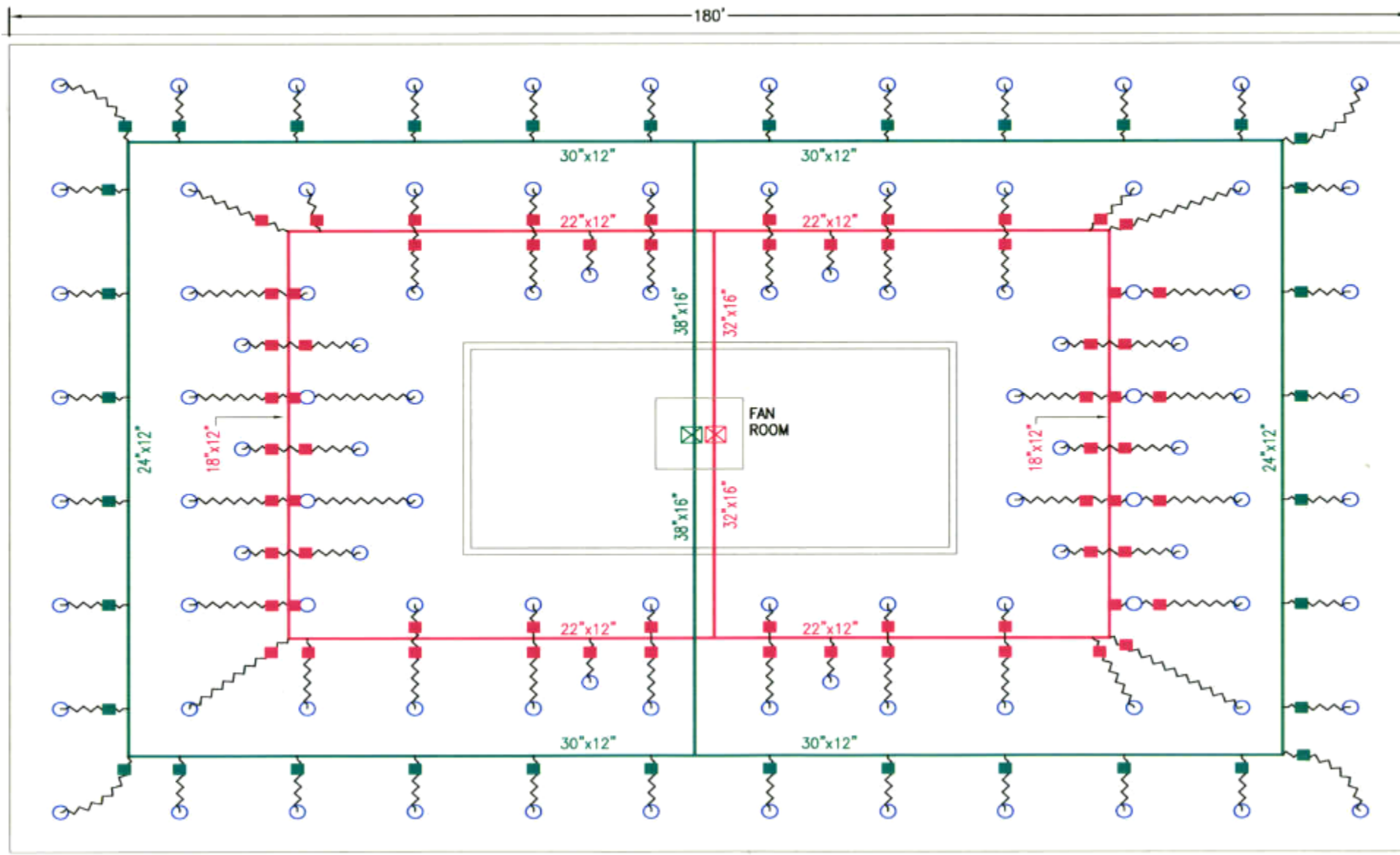
# AREA

PERIMETER	4,700 ft <sup>2</sup>
INTERIOR	15,100 ft <sup>2</sup>
CORE	1,800 ft <sup>2</sup>
TOTAL	21,600 ft <sup>2</sup>

## HVAC LAYOUT FOR INDIVIDUAL CONTROL

# AIR OUTLETS

36 PERIMETER	AVERAGE 325 CFM
64 INTERIOR	AVERAGE 125 CFM
TOTAL	19,700 CFM



### Cost of Typical System

Sheetmetal	10,937 lbs x 1.1 [for waste] x \$3.50/lb	\$42,100
Flex Duct	80 conn's x 8 ft x \$2.25/ft	\$ 1,450
Light Troffers	80 x \$45.00	\$ 3,600
Install Light Troffers	80 x \$35	\$ 2,800
VAV Terminals	22 @ 750 CFM x \$250.00	\$ 5,500
	6 @ 1500 CFM x \$325.00	\$ 1,950
Install VAV Terminals	28 x \$180	\$ 5,000
Profit and Tax on Equipment	\$12,490 x 0.25	\$3,100
DDC Thermostat Control	28 x \$560.00	\$15,700
Total		\$81,200

### Cost of Air Jet System

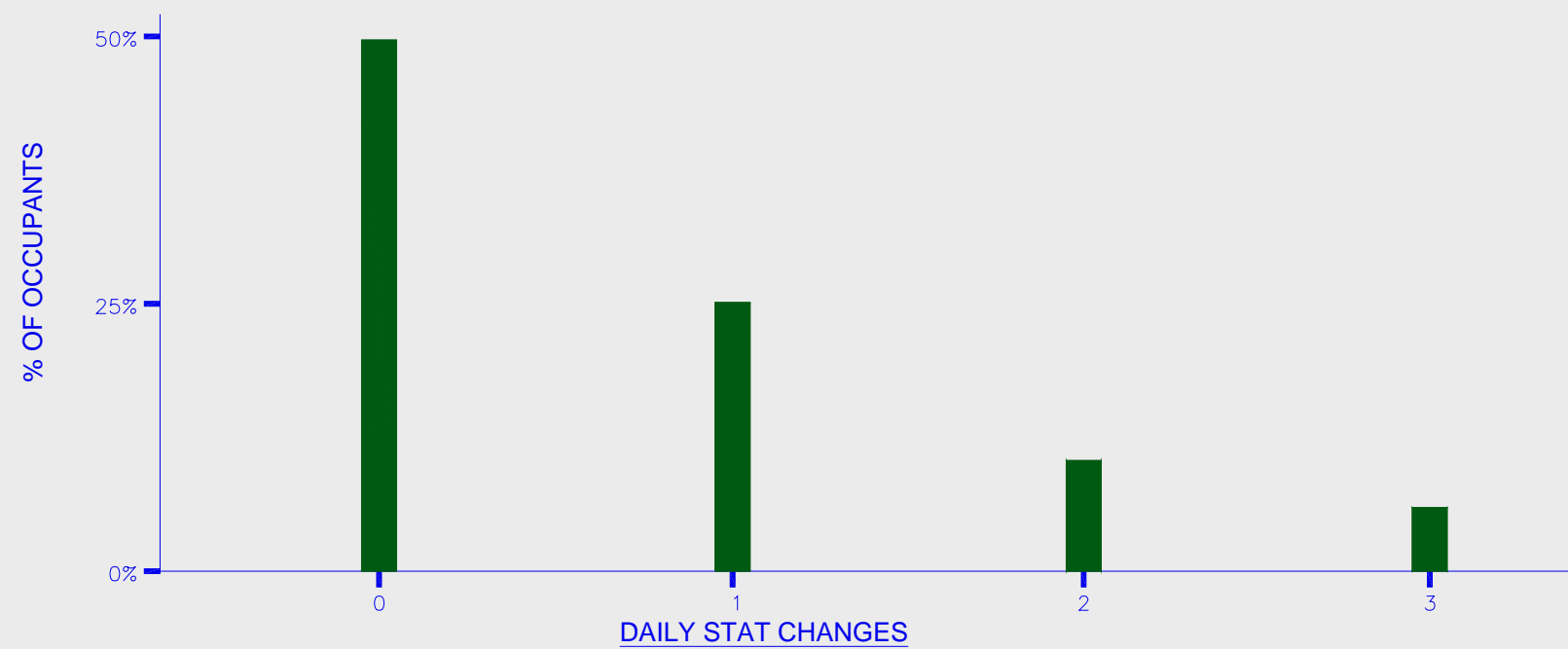
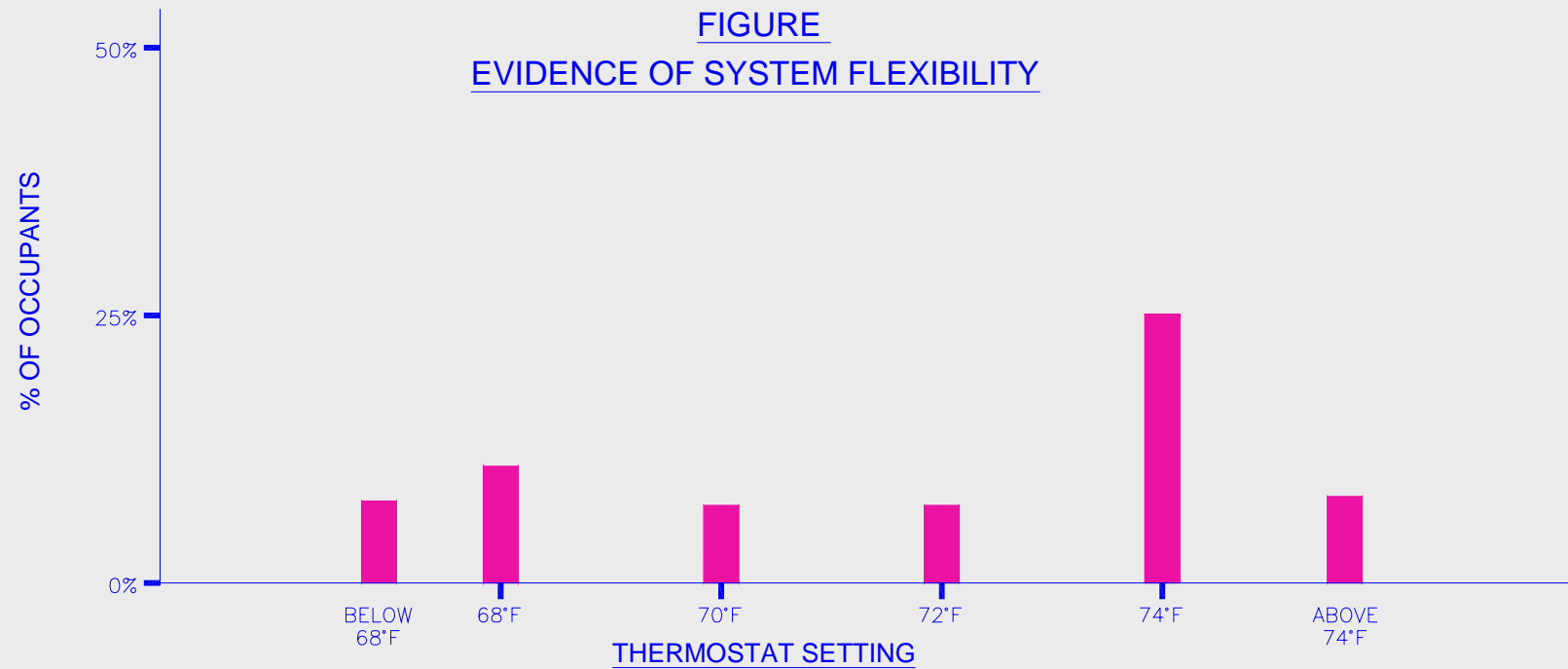
Sheetmetal	8,270 lbs x 1.1 [for waste] x \$3.50/lb	\$31,800
Acoutiflex Duct	100 conn's x 10 ft x \$3.00/ft	\$ 3,000
Cone Fittings	100 x \$25.00	\$ 2,500
Auto Dampers with 1/60/24 motors	100 x \$75	\$ 7,500
Air Jet Platforms	100 x \$75	\$ 7,500
Thermostats and Transformers	100 x \$225	\$ 22,500
Profit and Tax on Equipment	\$43,000 x 0.5	\$ 21,500
Wiring	100 x \$110	\$ 11,000
Total		\$107,300

**Premium for Jet System    \$26,100**  
**\$1.21/ft<sup>2</sup> of floor area**  
**\$ 261/person**  
**0.75% of \$35,000/yr salary**

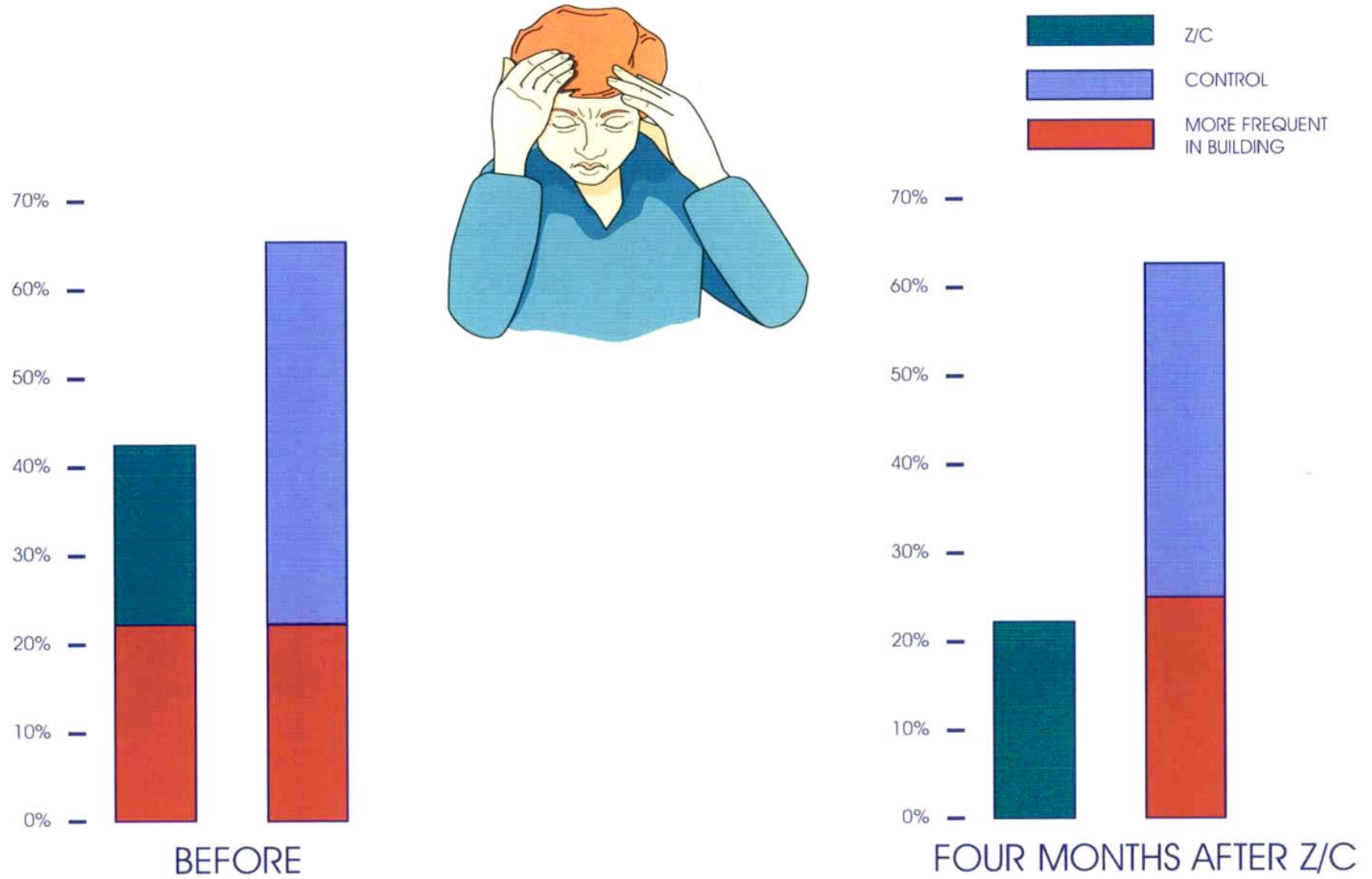
### COST COMPARISON OF VAV SYSTEMS



FIGURE  
EVIDENCE OF SYSTEM FLEXIBILITY



## HEAD ACHE

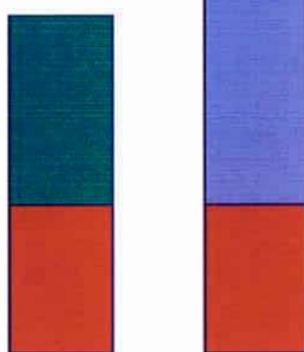


## TROUBLE STAYING AWAKE



60% —  
50% —  
40% —  
30% —  
20% —  
10% —  
0% —

BEFORE



60% —  
50% —  
40% —  
30% —  
20% —  
10% —  
0% —

FOUR MONTHS AFTER Z/C



## DRY OR IRRITATED THROAT

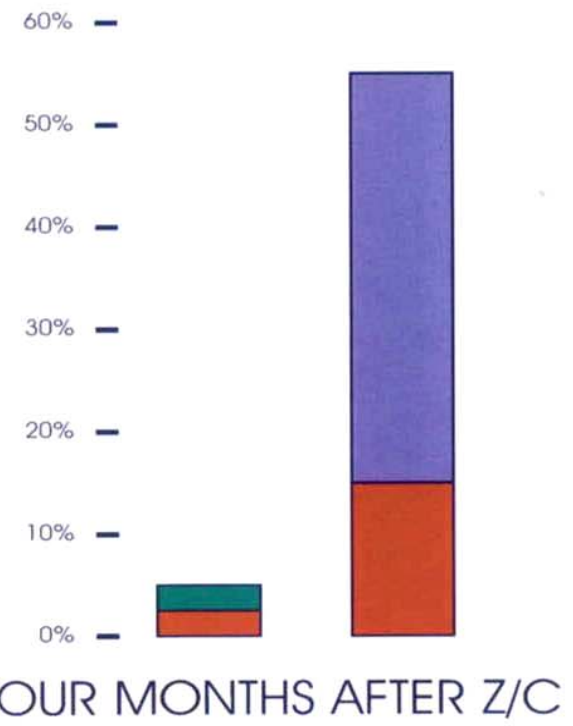
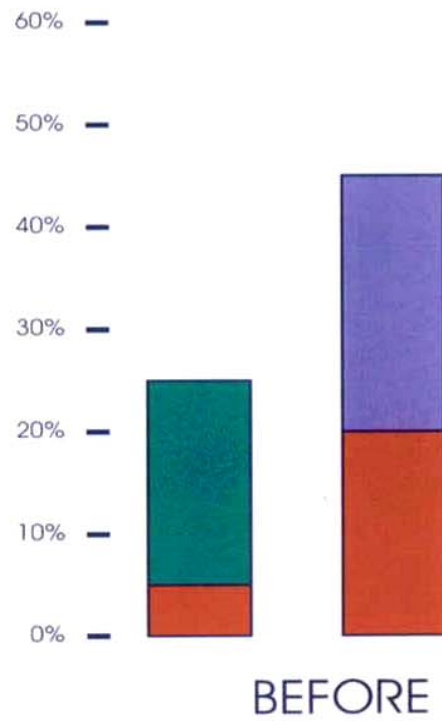
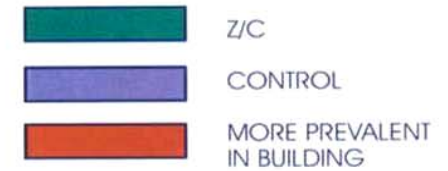
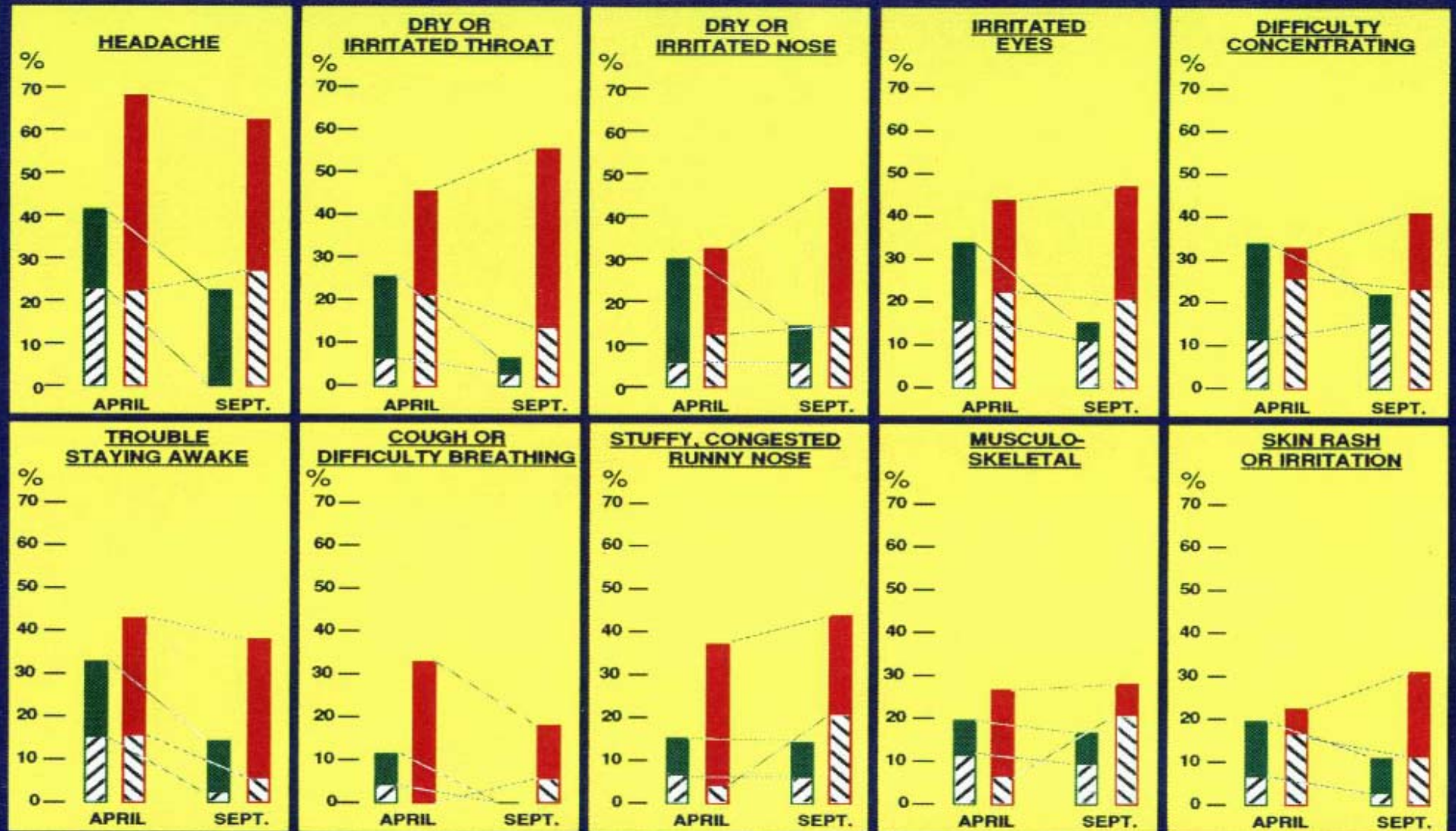


FIGURE 10



LEGEND

INTERVENTION FLOOR  
CONTROL FLOOR

NOTE

HATCHED AREAS SHOW PERCENTAGE ATTRIBUTED TO THE BUILDING ENVIRONMENT.

FIGURE

17. PLEASE RATE HOW MUCH CONTROL YOU  
HAVE OVER YOUR ENVIRONMENT: CIRCLE ONE

NO PERSONAL CONTROL	0	1	2	3	4	5	6	7	FULL PERSONAL CONTROL
---------------------------	---	---	---	---	---	---	---	---	-----------------------------

18. PLEASE RATE HOW MUCH YOU THINK THE HVAC  
CONDITIONS AT WORK INFLUENCE  
YOUR PRODUCTIVITY?

Decreased Productivity by

Increased Productivity by

30%

20%

10%

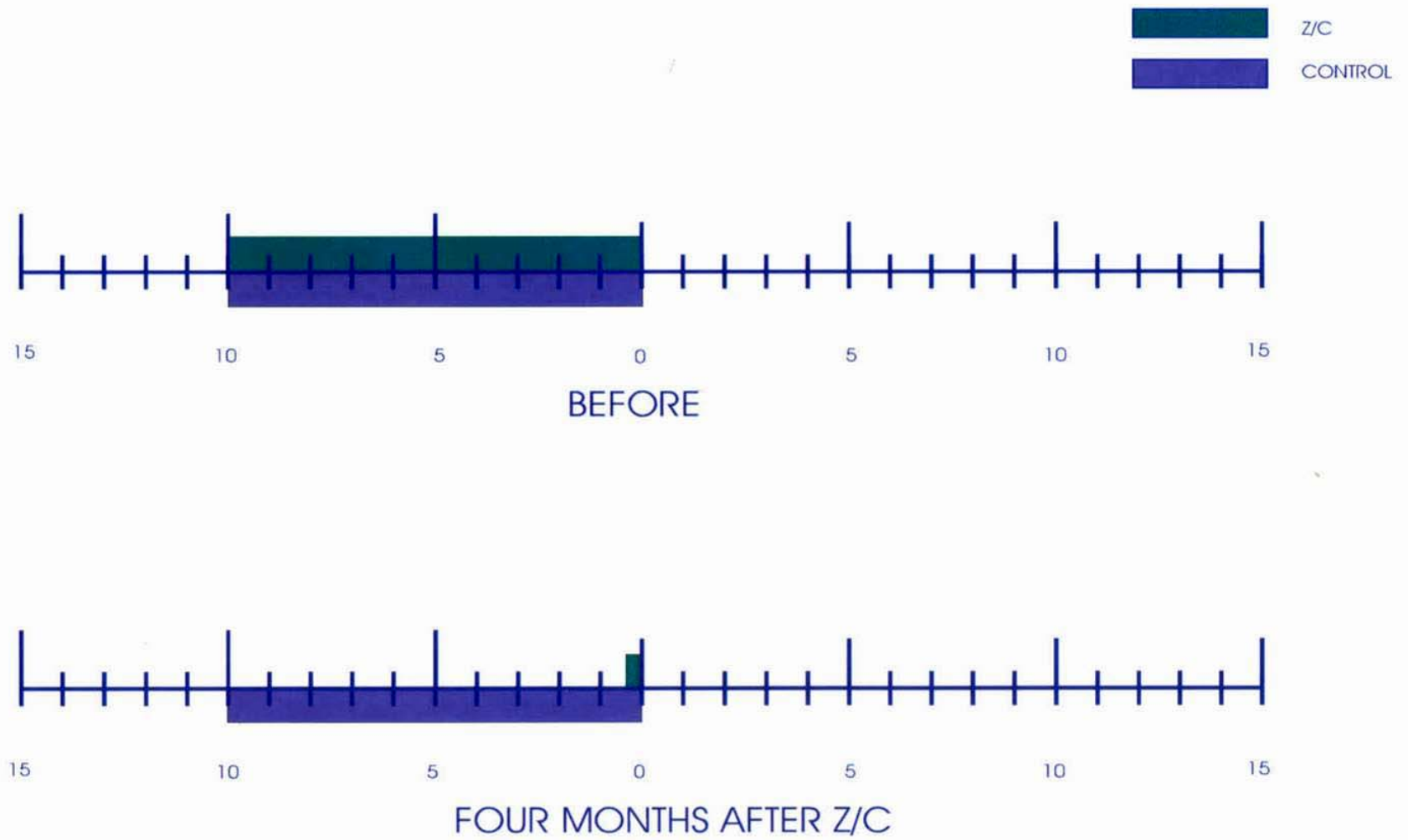
NO EFFECT

10%

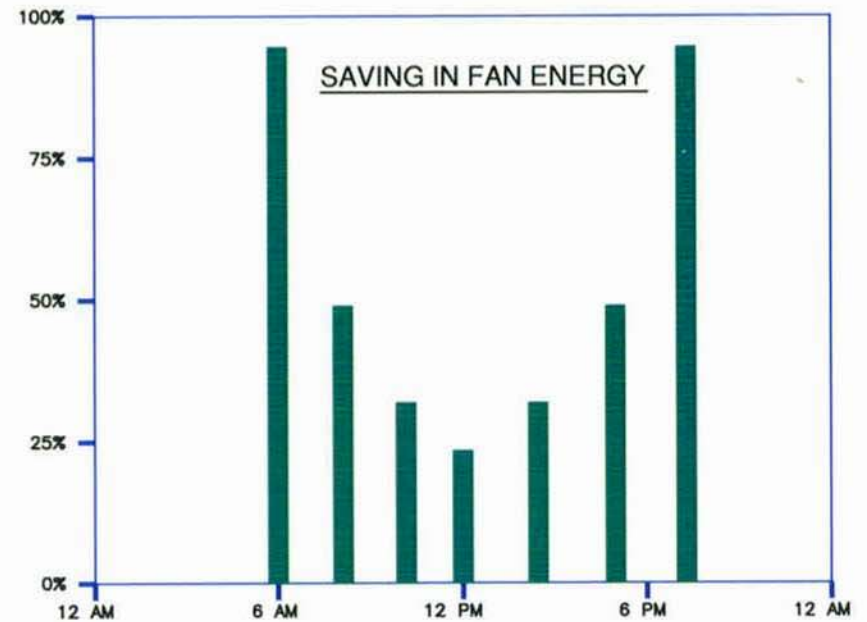
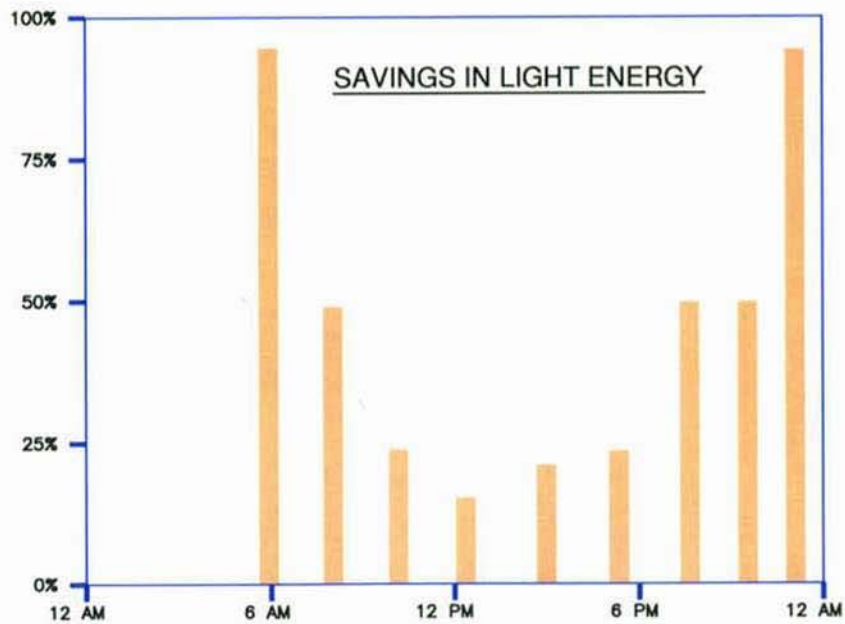
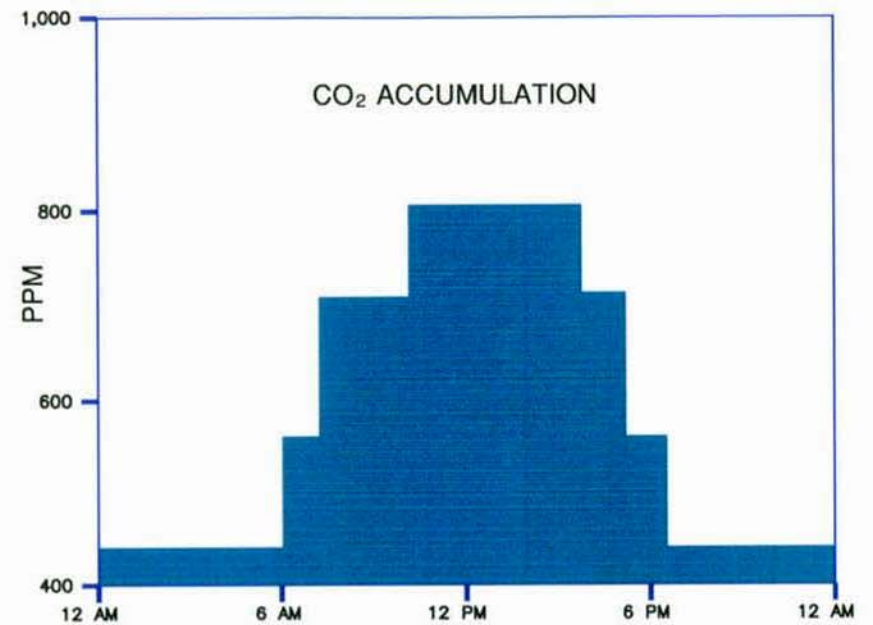
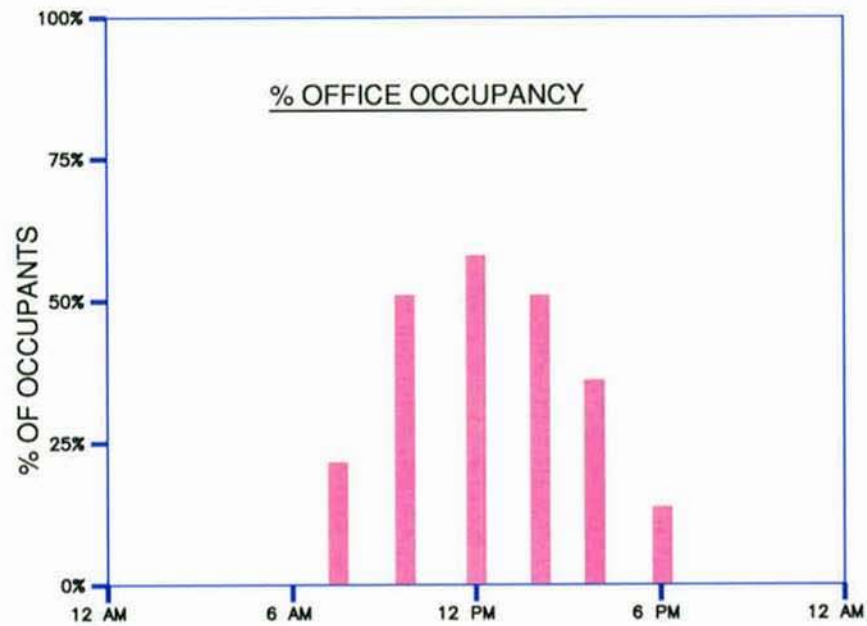
20%

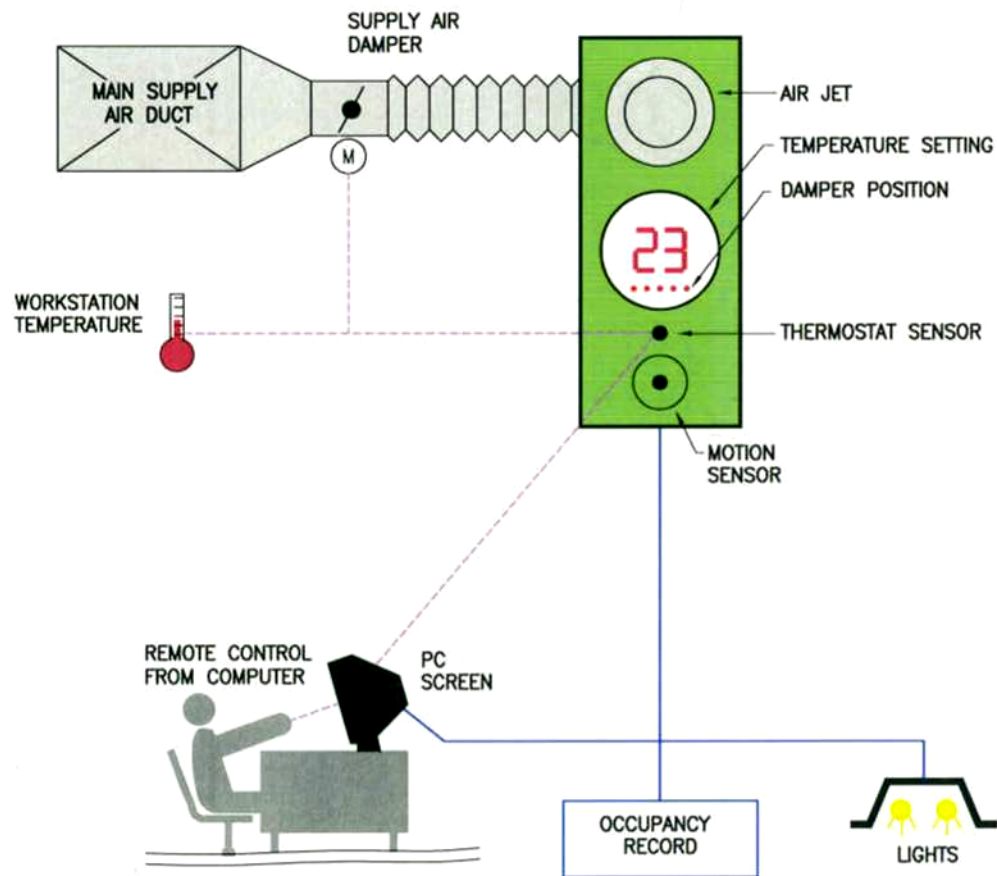
30%

## PRODUCTIVITY LOSS BECAUSE OF HVAC



## POTENTIAL FOR ENERGY SAVINGS WITH INDIVIDUAL CONTROL





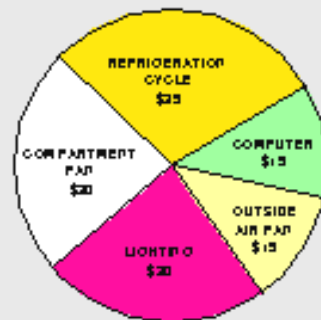
## ENHANCEMENT FOR ZERO COMPLAINT SYSTEM

### PART I

## PAYBACK SCENARIO FOR INDIVIDUAL CONTROL

### ASSUMPTIONS

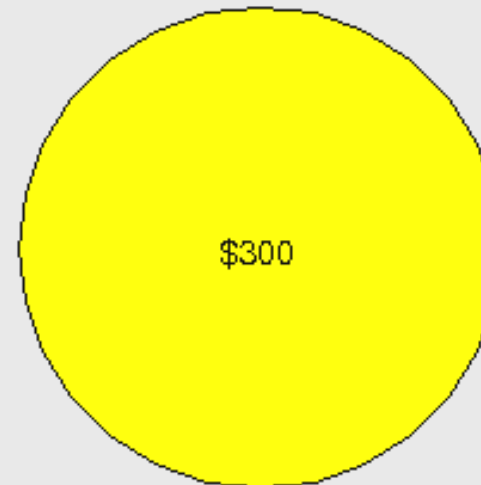
OCCUPANT SALARY .....	\$35,000/YR
OCCUPANT SPACE .....	200 FT <sup>2</sup>
LIGHTING .....	1 WATT/FT <sup>2</sup>
COMPARTMENT FAN .....	1 WATT/FT <sup>2</sup>
COMPUTER SCREEN .....	100 WATTS
TENANT ELECTRICAL LOAD .....	2 WATT/FT <sup>2</sup>
OUTSIDE AIR .....	30 CFM/PERSON
COOLING LOAD PER OCCUPANT . . .	@ 500 FT <sup>2</sup> /TON = 0.4 TONS
FULL LOAD COOLING EQUIV. HRS .....	2,200 HRS/YR
OPERATING TIME FOR LIGHTS/FANS . . .	5,000 HRS/YR
COST OF REFRIGERATION CYCLE .....	15 ¢ /TON HR
COST OF ELECTRICITY .....	10 ¢ /KWH



POTENTIAL ENERGY SAVINGS  
FOR ZERO COMPLAINT  
\$125 / YR

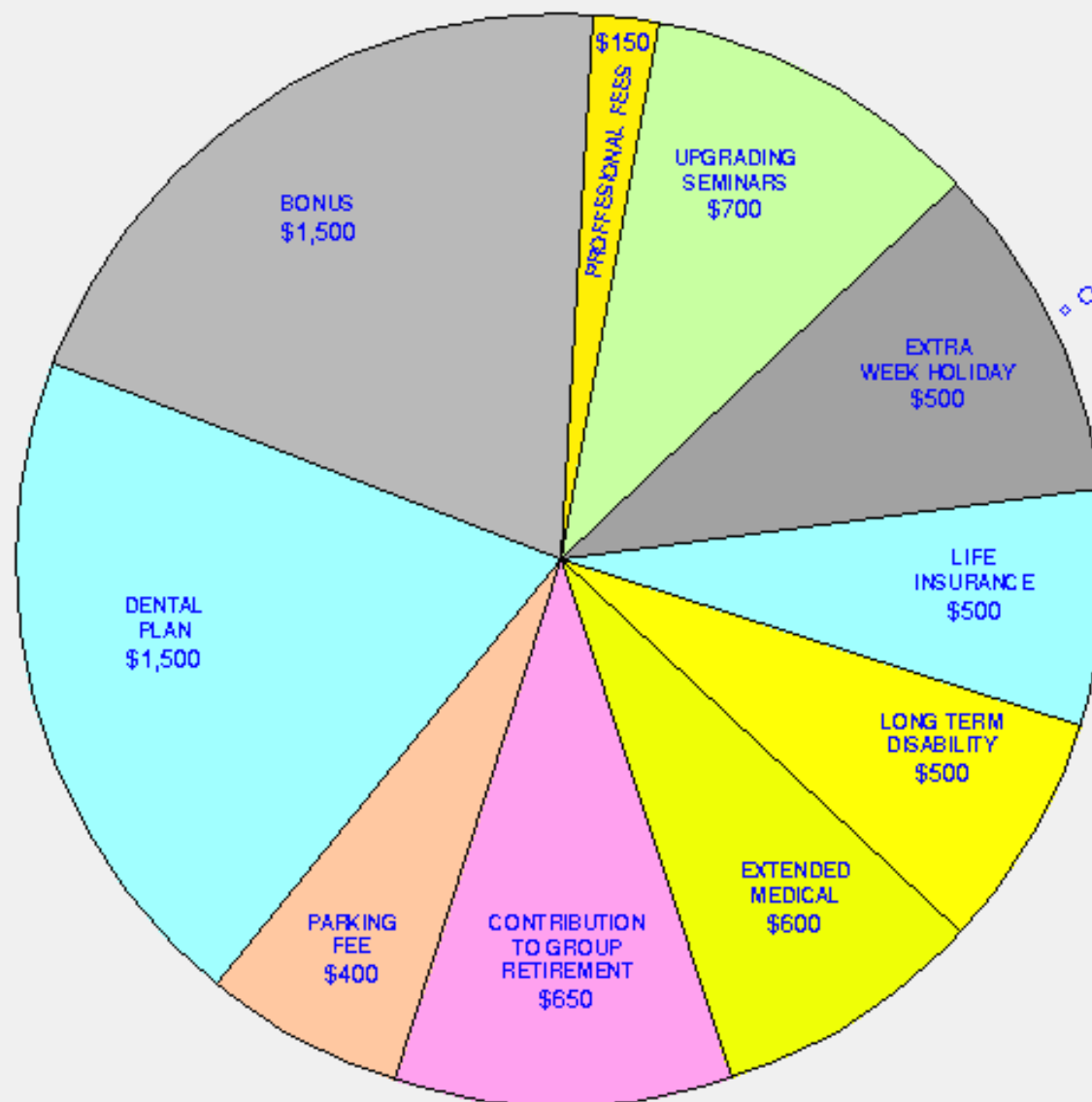
### PAYOUT SCHEDULE

WORKER EFFICIENCY IMPROVEMENT	TIME
0% .....	2.4 YRS
1.7% .....	1 YR
10% .....	42 DAYS



PREMIUM COST  
OF INDIVIDUAL CONTROL

SHOULD ZERO COMPLAINT BECOME ANOTHER EMPLOYEE BENEFIT????



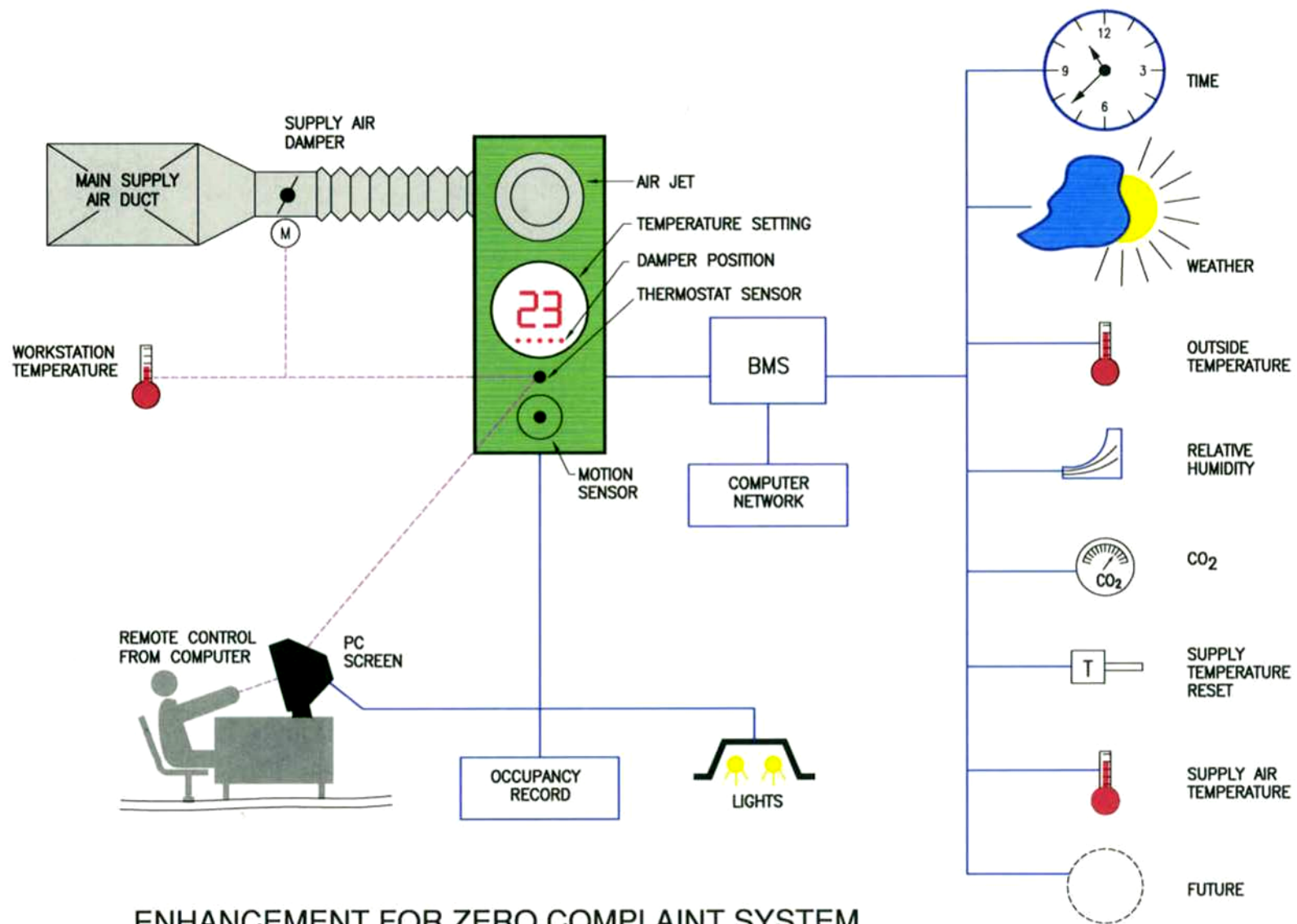
COST OF EMPLOYEE BENEFITS  
\$7,000/YEAR

OUR EMPLOYEES  
NOW ENJOY ALL THESE  
BENEFITS

BUT

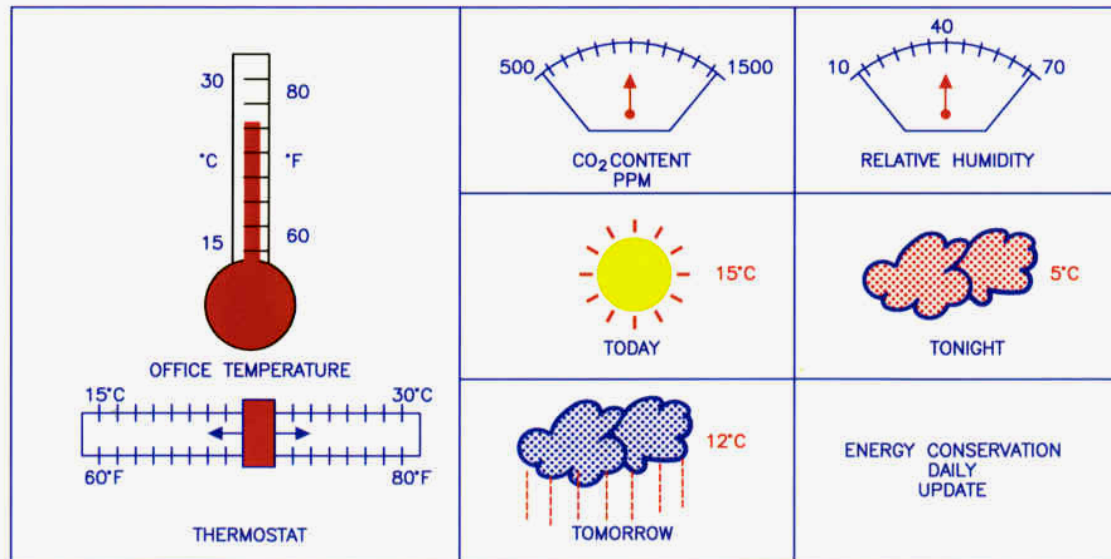
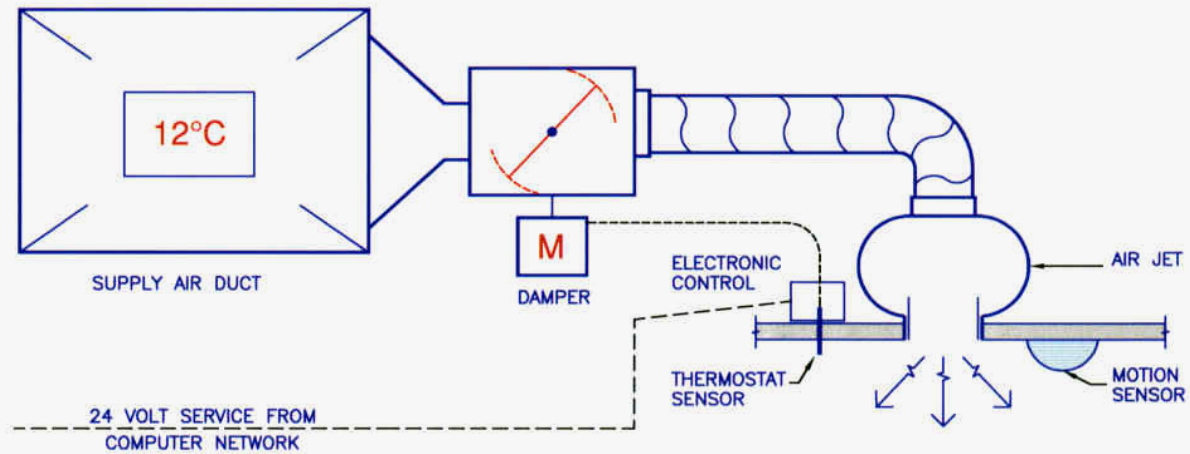
ONLY ZERO COMPLAINT  
CAN HAVE A STRONG  
RELATIONSHIP TO  
THEIR EFFICIENCY

COST OF ZERO COMPLAINT  
\$300 ONE TIME



## ENHANCEMENT FOR ZERO COMPLAINT SYSTEM PART II

## ZERO COMPLAINT SYSTEM COMPUTER SCREEN



## COMFORT CONTROL PANEL